

Building 450 Chilled/Tower/Process Water Control Sequence of Operations

Chilled Water System

General

The chilled water system, will be enabled through a manual command from the building operating engineer by setting binary data point 'CLG_STRT', DN from the building 450 ICS Operator Workstation. Each chiller system, CH-801, CH-802 and CH-803 can be enabled individually by the chiller control network.

The digital controller panel will provide a start/stop command to the chiller control network that will enable the chilled water system. This is a manual command from the ICS operator workstation. The ICS will monitor their status and alarm condition through unit supplied contacts.

Individual Chiller Operation

After a command from the dedicated chiller control system to start either chiller, CH-801, CH-802 or CH-803, the following action will take place:

1. Start condenser and secondary chilled water pumps according to schedule one. The Chiller/Pump designation will be based on the selected mode number (analog data point, CH/P_SEQ). The operating engineer will enter either a '1' or '2' at any ICS terminal to dictate the Chiller/Pump designation. See schedule one(1) for operation sequence. The individual chiller machine will start primary chilled water pumps, P-801 - P-804.
2. Start primary chiller water pump.
3. Open two position condenser water isolation valve.

The digital controller panel will provide the start/stop command for each chilled and condenser water pump and will monitor their status through feedback devices, differential pressure switches, PS-1 - PS-10. The controller will issue an alarm, 'Pump, P-8 Failure' to the ICS network if the status of the feedback device does not match the command. After flow has been proven in both the chilled and condenser water circuits by their respective flow switches, the chiller will initiate its internally controlled startup sequence.

The following system points will be monitored by digital control panel, EN-02001 and the associated hardware indicated on the schedule below. These points will be objects on the ICS network and will be visible/adjustable from any node terminal.

Point name	Assoc hardware	Object Name	Initial Value
Chilled Water Supply Temp	TE-9	CHWS-T	
Chilled Water Return Temp	TE-10	CHWR-T	
Clg Wtr Water Supply Temp	TE-7	TWS-T	
Clg Wtr Water Return Temp	TE-8	TWR-T	
Primary CHWP S/S & Status	FW-1-FW-6	CDW-FLOW, CHW-FLOW	

Adjustable Objects

Chiller/Pump Designation	CH-XXX, CH/CHWP-XXX	CH/P_SEQ	1
Minimum CHWP Speed	P-812-P-814	CHWP-MIN	20.0 %
CHW Diff Pressure Setpoint	DPT-1	CHWP-SP	30.0 PSI

The following chiller points for each machine will be adjustable from any ICS terminal.

Function	ICS Object Name
Remote current limit	AMP-LIM
Remote Setpoint Adj.	CHW-STPT

The remote current limit can be adjusted between an analog value of 50 and 100 percent. The remote setpoint adjust will allow the operating engineer to reset the chilled water supply setpoint for each machine.

Chilled Water Pump Capacity Control

As a different number of heat exchangers are being used chilled water circuit differential pressure will dictate the position of the two variable speed chilled water pumps, P-816 and P-817, one unit designated as a standby pump. Once either primary DI water pump P-816 or P-817 is started manually, the lead pump will be ramped up over a period of five min.(adj). After the ramp timer has expired the digital controller will modulate the position of the enabled pump to maintain a chilled water differential pressure setpoint of 50 psi(adjustable at the operator workstation) at differential pressure transmitter, PT-1. See JC drawing 91-9-A-02A for a note indicating the location of PT-1. If the position of the operating chilled water pump is greater than 90 percent for more than 5 min(adj), the digital control panel will enable primary chilled water pump P-813. The digital control panel will now modulate both pumps in parallel to maintain the differential pressure setpoint. If the position both pumps is less than 50 % (adj) for more than 15 minutes, the controller will disable the second pump in the sequence and the single operating unit will be modulated to maintain the differential pressure setpoint.

Chilled Water Differential Pressure High Limit

In the event that the chilled water differential pressure exceeds 80 PSI, as read by differential pressure transmitter, PT-1, the digital control panel will set binary data point CHW-HDP and an alarm will be issued to the ICS network, 'High Chilled Water Differential Pressure Event'. The controller will command the CHWP(s) position to zero. After the alarm has been acknowledged, the digital control panel will initiate the control sequence from the ramping function as indicated above in 'Chilled Water Pump Capacity Control'.

Cooling Tower Control

General

The cooling towers will be active if at least one chiller machine or at least one process water heat exchanger is enabled. Each cooling tower cell operates at two stages of capacity, with a modulating bypass control valve, V-1. The following sequence indicates the tower/chiller/heat exchanger and tower pump designations:

Schedule one

CHWP Tag	Chiller Tag	Clg Wtr Tag	CH-P_SEQ
P-805	CH-801	CT-801	1
P-806	CH-802	CT-802	1
P-807	CH-803	CT-803	1
P-811	Standby		1

CHWP Tag	Chiller Tag	Clg Wtr Tag	CH-P_SEQ
P-805	CH-803	CT-801	2
P-806	CH-802	CT-802	2
P-807	CH-801	CT-803	2
P-811	Standby		2

CHWP Tag	Heat Exchanger Tag	Clg Wtr Tag	HE-P_SEQ
P-808	ANY HE	CT-804	1
P-809	ANY HE	CT-805	1
P-810	ANY HE	CT-806	1
P-811	Standby		1

CHWP Tag	Heat Exchanger Tag	Clg Wtr Tag	HE-P_SEQ
P-808	ANY HE	CT-806	2
P-809	ANY HE	CT-805	2
P-810	ANY HE	CT-804	2
P-811	Standby		2

Notes: 1. The condenser water pump/cooling tower match is fixed and is not adjustable.

For each individual tower cell, the digital control panel, EN-02001 will modulate controlled devices, bypass valve, V-1 and two stages of fan speed within the control loop's proportional band to maintain a cooling tower water supply temperature setpoint. See 'Summer and Winter Modes of operation for TVS setpoint values.

Tower Cell P/I Control Output

Controlled Device Position
0 Percent
25 Percent
50 Percent
75 Percent
100 Percent
130 Percent
190 Percent
200 Percent

Mode of Operation

Summer

This mode is active at outdoor dry bulb temperatures(TE-16) greater than 40 F. The TVS temperature setpoint will be adjusted by the digital controller, NCM-2 according to the following criteria:

At outdoor wetbulb temperatures(Twb),(HT-1 and TE-16) greater than 78 F., the the cooling tower water supply temperature(TVS) setpoint will be 83.0 F. at outdoor wetbulb temperatures below 78 F., the TVS setpoint will be four(4.0) degrees greater than Twb.

Winter

This mode is active at outdoor dry bulb temperatures less than 40 F. The TVS temperature setpoint will be set at 78 F.(adj)

Cooling Tower Basin Level Control

Digital control panel, EN-02102 will cycle two position feedwater valve open at a level 16 inches below the reference line and will close the valve at a level 12 inches below the reference line. Setpoints are adjustable from any ICS terminal. An analog reading to the basin level will be updated at the DWS at an interval of 20 seconds. Alarm limits of -2 and -9 inches will be assigned to the basin level object. This sequence applies to both the north and south basins.

The following system points will be Objects on the ICS Network and can be viewed/alarmed and/or adjusted from any ICS terminal:

System Point	ICS Object Name
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TVS Temp.	TVS-T
TWR Temp.	TWR-T
T-CELL/CH/PUMP DES	SEE SCHEDULE ONE
T-CELL/HE/PUMP DES	SEE SCHEDULE ONE
TVS HI TEMP	TVS-ALM
TWR HI TEMP	TWR-ALM
LOW BASIN LEVEL	BASIN-LO
HIGH BASIN LEVEL	BASIN-HI
LOW BASIN TEMP	LO-B-T

Process Water Heat Exchanger Control

Once a system is enabled, the digital controller will perform the following:

1. Open the heat exchanger's respective process water isolation valve, V-1 - V-3.
2. Start cooling tower water bridge pump, P-818 - P-820 through end switches.
3. Enable the cooling tower water control circuit. See 'Cooling Tower Control' above.
4. Enable heat exchanger mixing valve control, V-5A,5B - V-7A,7B.

P-815-P-817 VARIABLE SPEED CONTROL

PROCESS WATER SYSTEM ENABLE-IN THE EVENT ANY HEAT EXCHANGER IS ENABLED

THE DIGITAL CONTROLLER, EN-011002 WILL START PUMPS P-816-17 AND MODULATE THEIR SPEED TO MAINTAIN A DIFFERENTIAL PRESSURE SETPOINT OF 20 PSI AT DIFFERENTIAL PRESSURE TRANSMITTER, PT-1. IF THE SPEED OF PUMPS P-816-17, EXCEEDS 90 % (ADJ.) FOR MORE THAN 15 MINUTES, THE CONTROL SYSTEM WILL ENABLE PUMP, P-815. THE CONTROLLER WILL CONTINUE TO MODULATE THE SPEED OF PUMP SET, P-816-17 TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINT. IF THE SPEED OF THE VFD PUMP SET DROPS BELOW 50 PERCENT FOR MORE THAN 15 MIN(ADJ.), THE CONTROL SYSTEM WILL STOP PUMP P-815.

Heat Exchanger, HE-804

1. Open the heat exchanger process water isolation valve, V-3B
2. Process water pump, P-821 will be controlled manually.

The digital controller will modulate control valve, CV-1 to maintain a PWS temperature setpoint of 73 F. at temperature element, TE-5.(adjustable)

PROCESS WATER SYSTEM DISABLE

ALL PUMPS WILL REMAIN OFF.

The Heat Exchanger/Pump designation will be based on the selected mode number.(analog data point, HE/P_SEQ.) The operating engineer will enter a '1' or '2' at any ICS terminal to dictate the Heat Exchanger/Pump designation. See schedule one(1) for operation sequence.

The digital control panel, EN-01002 will modulate heat exchanger mixing valves to maintain a process water discharge temperature setpoint of 74 F. (adjustable at any ICS terminal) Temperature elements, TE-5 and TE-6 will indicate to the ICS the overall process water supply and return temperatures respectively.

DRAWING TITLE	Sequence of Operations	RECORD	06/08/94	5F
Building 450 Utilities		4 REV HE-804 SEQ	03/01/94	5F
Chilled/Tower/Process Water		3 GENERAL	09/08/94	5F
Systems		REFERENCE DRAWING NO. REVISION-LOCATION	ECN	DATE BY
SALES ENGR PROJECT MGR/APPL ENGR	JP	SF	OCS	DATE 01/03/92 BY
PROJECT	The Argonne National Labs Advanced Photon Source Campus 9700 Cass Avenue South Argonne, IL 60439	JOHNSON CONTROLS Systems & Services Division	3007 MALMO ROAD ARLINGTON HEIGHTS ILLINOIS 60005 708/364-1500 Main 708/808-4438 Eng	CONTRACT NUMBER 91390-0009 DRAWING NUMBER 91-9-A-01A